Evaluation of the Workplace Environment in the UK, and the Impact on Users' Levels of Stimulation

1.0 Introduction

1.1 Stimulation and the Workplace Environment

During the 20th and 21st Centuries, a number of independent investigations into the workplace environment and the relationship with stimulation levels have been conducted. For example, it has been demonstrated that there are associations between temperature and stimulation [1]; and colour and stimulation [2]. An early psychological principle from 1908, is Yerkes-Dodson law of arousal [3], which suggests that there is an optimal level of arousal for the performance of tasks. It has been shown that people's level of stimulation varies throughout the day and that it usually follows a pattern in which the majority of people feel less stimulated in the early afternoon than in the morning. This is represented by a sharp drop in arousal levels immediately after the traditional lunch break [4-8]. Reductions in levels of productivity have been related to this phenomenon.

1.2 Post-occupancy Evaluation

Feedback from participants is considered good practice in any field of human endeavour. In this case, it relates to the evaluation of the environmental quality in recently completed workplaces; and by implication a review of the design and management decisions that created them. In fact, as there is no requirement for independent post-occupancy evaluations, they rarely take place, and a disproportionate number have been undertaken for commercial purposes. The methodology, sampling and the reporting of results in these instances, may therefore have been distorted by commercial imperatives. Thus, case study evidence of this kind can be misleading. An analysis of post-occupancy evaluation techniques reveals a variety of objectives and methodologies. The studies include Duffy [9], Laing et al. [10], Cohen et al. [11-12], Markus [13], Oseland [14] and Davis et al. [15]. One group of studies focuses on satisfaction in the workplace and in some cases on the relationship between the environment and a form of productivity (either real or perceived). Among the more comprehensive methodologies are: Brill et al. [16], which takes the form of a staff questionnaire and objective measurement of the internal environment; those by Preiser et al. [17] in which users are asked how satisfied they are with their environment; and the Leaman and Bordass *Post-occupancy Review of Buildings and their Engineering (Probe)* study [18] which comprises a user survey and energy assessment. Yet, even these studies do not offer fully balanced approaches to the assessment of stimulation and none address the integration of features to counteract the drop in arousal levels.

1.3 Research Aims

The purpose of this paper is to review aspects in the workplace environment that may have a significant impact on stimulation. After which, Study 1 will test these aspects in sixteen workplaces to gain the users' perception of them. The purpose of Study 2 is to determine whether changes to significant aspects of the workplace

environment during the day can counteract the reduction in users' stimulation from morning to afternoon.

2.0 Review of Aspects in the Workplace Environment

2.1 Internal Climate

It is noted that most of the research into the workplace environment has been into aspects of internal climate, including: Chiles [19], Fanger [20], Egan [21], Boyce [22], Heerwagen & Heerwage [23], Baron & Rea [24], Biner [25], Croome at al. [26], Abdou & Lorsch [1], Carter et al. [27], Loe & Rowlands [28], de Dear [29], de Dear & Brage [30], Jones [31], Banbury & Berry [32], Tanabe et al. [33], Zhang et al. [34], Gossauer & Wagner [35], Kaarlela-Tuomaala et al. [36] and Hwang & Kim [37]. The emphasis on measurement of temperature, humidity, air movement, illuminance and noise - has enabled design standards to be established, as shown in table 1, and these are routinely achieved in the design of new workplaces.

temperature	21-26 deg C [38-39]
humidity	30% -70-% [40]
air movement	0.05 m/s – 0.25 m/s [40]
illuminance	300-500 lux [41]
background noise for conversation	60dB [42-43]

Table 1: Internal Climate Standards

These standards are summarized in the CIBSE Guide A: Environmental Design [44].

2.2 Interior Design

During the 20th Century, space allocated to employees was a reflection of their status rather than process driven [45]. Konar [46] found that a spatial layout which was considered to be appropriate to status meant that individuals were more satisfied with their work and perceived themselves to be more productive. The evolution of management based on human relations theory produced organisations in which there is a flatter structure. Consequently, more recent space standards are given as areas per person rather than being designated by role. The development of management practice was followed by alternative forms of spatial layout. From the 1970s, open plan offices became the most popular as the benefits of human relations theory were realised and this type of layout supported interactive ways of working [9, 15]. However, the workplace environment is more complex than just spatial layout. The whole interior design needs to be investigated, including aspects such as – decor and plants.

The aspect of decor that has received the most research attention is the colour scheme and particularly preferences for certain colours [47]. Whilst providing an objective measurement of colour - hue, brightness and saturation do not reveal how the different colours are perceived by individuals or their psychological impact. As a result of a lack of research into this aspect of the workplace, designers often choose

fashionable colours [48] or those that match the preference of the office manager [49]. Brill et al. [16] found that people express a preference for workplace environments in which there are a number of colours, although they found it difficult to draw any firm conclusions about the direct impact of colour upon performance. The other principal aspect of decor is the display of artwork. Again, there are few empirical studies that confirm the impact of art on workers, but previous research has provided an indication of the impact of art in conjunction with a colour scheme. For example, Stone [50] found that a picture of a nature scene had a positive impact upon task performance if the room was red in colour. By contrast, the same image in a room coloured blue had a negative impact upon performance of a task. Stone [50] argues that the results are due to the impact of the environment upon stimulation levels of participants. Nevertheless, the impact of the different aspects of decor ie colour and artwork, and replicability across workplaces is not clear; and further research is required. The number of plants in a workplace have been positively correlated with perceived stimulation [51–55]. However, published empirical research into the impact of plants in the workplace is limited and therefore no firm conclusions can be drawn.

2.3 Workplace Features

In addition, there are workplace features, which include – daylight, view, comfort, taking a break, personal control and choice. Traditionally windows performed the essential functions of providing natural light, to enable workers to see what they were doing; and offering natural ventilation. With the introduction of artificial light and mechanical ventilation systems, the provision of windows is no longer a necessity to allow people to complete their work. Despite the non-essential function of windows, they are still considered important. It has been demonstrated that workplace users have a preference for daylight [23]. Further to the provision of daylight, windows provide a second major benefit of a view. This offers a connection to the outside world [56-58]. Although research into daylight and view supports the inclusion of large windows to maximise daylight and access to views, the provision has to be balanced with the need to prevent glare and solar heat gain which are linked with dissatisfaction [58]. In the Ne'eman and Hopkinson [59] study, participants were asked to assess the size of windows in terms of preference within a scale model of a workplace environment. Their findings demonstrated that it was not the amount of internal or external light that stimulated the users, but the view. The importance of view in determining distance of a workstation from a window, has been supported by other research [eg. 60-62].

Personal control is the ability to alter the internal climate [63]. There is still some debate about the association between personal control and productivity, but a high proportion of research supports the notion that control has a positive impact on stimulation [64]. Nevertheless, most workplaces constructed from the latter part of the 20th Century are part of energy conscious design and offer little personal control [65]; despite the widely held belief that it is unreasonable to expect all people to be satisfied within a uniformly controlled environment [66-68]. Satisfying employees' personal needs is not as simple as merely supplying each of them with individual control over their own environmental conditions. The system has to satisfy each individual's needs, without having a negative impact upon the environment of others. The introduction of effective personal control therefore requires a holistic approach to evaluating its impact, and consideration of the most effective way in which to implement it. In determining the design of workplaces, there needs to be strong and credible leadership from the management of the organisation, so as not to appear to be waiting for direction. Yet, it is also vital that users engage and take metaphorical

ownership of their workplace. There is an argument that the opinions of every member of a large workforce cannot be taken into account, but everybody should feel that they have had a choice. Open, unambiguous, timely and relevant communication is clearly valuable to effective user engagement. Choices for workers could be based on the principles of the design and the atmosphere to be generated, rather than detailed issues [69].

As workplaces evolved to reflect changing management theory, furniture provision allowed designers to create different styles of workplace. Also Dul [70] argues that "*the value of ergonomics is beyond health and safety. With ergonomically designed work environments a company can reach a competitive advantage*." Brill et al. [16] found that comfort at the workstation is significantly correlated with stimulation. Kroemer and Kroemer [71] and McKeown [72] note that something as simple as having a back rest on the chair and adjustable height and tilt, make a significant difference to comfort. Helander et al. [73] identified a range of objective measures for the design of chair components. With a large sample, they assessed each dimension in relation to frequency of body discomfort experienced by the users. Research of this kind into furniture provision has provided information to enable design guidance to be created for workplace chairs and desks [eg. 74]. Yet, beyond the ergonomics of sitting at a desk, there appears to be a lack of empirical research into the impact of furniture design and how this interacts with other aspects of the workplace. Comfort is also related to the period of time between breaks [75]. In the UK, employment law states that employers are required to provide a 10 minute break for every 4 consecutive hours worked [76]. In practice, this is generally interpreted as a one hour lunch break in a standard 7.5 hour working day (37.5 hour working week). During the 20th Century, coffee and tea breaks were introduced in mid-morning and mid-afternoon, but these have been discontinued by many employers. A further complication is that 21st Century employment involves considerable amounts of computer-based work. The advice is that workers should not spend long periods at a computer. The Health and Safety Executive recommends that frequent short breaks are better than fewer long ones [77]. While a workstation may be initially perceived by users as comfortable, extended periods of time in the same position can engender discomfort [78]. Break areas are now a feature of workplaces, with the British Council for Offices [74] recommending that they should be included in all workplaces to enhance quality of life. This can have a positive impact upon users by allowing them to restore their attention levels [79]. There has been limited empirical evidence of the impact of break areas, particularly on satisfaction or perceived productivity levels. Yet, research into focused attention [80], the benefits of restoring concentration levels by taking a break [71], and the types of environments which have been found to be restorative [81], indicate that their inclusion should have positive effects.

Aspects of the workplace environment have therefore been identified and set into categories as follows:

- Internal Climate – temperature, humidity, air movement, illuminance, noise,
- Interior Design – spatial layout, colour, artwork, plants
- Workplace Features – daylight, view, personal control of the internal climate, choice, comfort, breaks

3.0 Study 1: Workplace Evaluation and Perceived Stimulation

3.1 Objectives of Workplace Evaluation

A review of the current state of knowledge has identified issues, deficiencies, and scope for further contributions to knowledge. In analysing each aspect of the workplace individually, it is assumed that users' experience of the environment is simply the result of the sum of isolated experiences. This may be inaccurate. Thus, the workplace as a whole in a real world setting should be analysed to give a more complete understanding of the impact of its environment. As evaluations have usually been undertaken by discrete academic disciplines, it has meant that they are either objective measurements of the workplace environment or analyses of users' perceptions. Few studies have focused on both. Most attention has been given to easily quantifiable aspects of the workplace environment, while less quantifiable aspects have often been neglected. Thus the research question for Study 1 is:

Which aspects of the workplace environment are the significant predictors of users' perceived stimulation levels?

3.2 Methodology

3.2.1 Participating Organisations

Eligible workplaces were selected by the criterion that the new design had been occupied for at least one year. This period enables the users sufficient time to settle into the building and determine the way in which they wish to use the environment. Researchers have recommended that a post-occupancy evaluation of any description should not be undertaken less than one year after occupation as the true impact of the environment will be masked by other factors such as a sense of being somewhere new and different [82]. Eighteen organisations in separate workplaces were identified in the locality as being eligible. They represent the design output of a single architectural practice, over a five year period – offering consistency of approach. Of these, sixteen agreed to take part giving a high overall acceptance rate of 89%. The nature of the businesses and overall design of the workplaces are highlighted in Table 2.

Workplace	Number of Users	Nature of Business	Description
A	11	Financial services	Open plan
B	27	Property investment and development	Open plan, some cellular (less than 25%) for directors
C	55	Development of social housing (administration, legal, finance)	Open plan with some cellular offices (less than 10%) for directors
D	56	Planning agency	Open plan, some cellular (less than 5%) for directors
E	69	Examinations and training administration	Open plan, some cellular (less than 5%) for directors
F	81	Print broker and stationary distribution	Open plan, some cellular (less than 10%) for directors
G	100	Chemical research and manufacture	Hot desk open plan, cellular (less than 10%) offices for directors and laboratory space for the majority of staff
H	116	Manufacturers and developers of chemicals	Open plan offices and some laboratory space
I	130	Insurance	Small enclosed offices with some small open-plan space for administrative staff

J	180	Public transport provider head office	Mix of open plan and cellular (less than 50%)
K	180	Accountancy	Open plan
L	350	Customer service centre (telephone based)	Open plan with some cubicles (formed with moveable internal partition panels)
M	461	Manage and accommodate charitable organisations	Small, enclosed offices with between 1 and 20 users (separated by charity)
N	850	Insurance	Open plan, some cellular (less than 15%) for directors
O	1,000	Administrative offices	Open plan, some cellular and small enclosed offices (less than 10%)
P	1,500	Call centre and training centre	Open plan with some small offices (less than 10%)
total	5,166		

Table 2: Details of the Participating Organisations

3.2.2 Procedure

An initial meeting was arranged with each organisation to obtain agreement to proceed with the data collection. Important parts of this agreement were confidentiality and anonymity for all involved. The other purpose of the meeting was to set the context for the evaluation, to gain an understanding of each organisation, and to receive a strategic and operational overview of the workplace environment. It was also agreed how the briefing of the participants would be undertaken. A Workplace Evaluation Questionnaire (see Appendix) was then developed specifically for this research, partly using reliable and rigorously tested user surveys, such a Oseland [14], Cohen et al. [12], and Leaman and Bordass [18]; and partly including other aspects indentified in the literature.

The paper-based questionnaire was handed to all participants by the researcher. The pre-set choice of responses to the questions was constructed so that every respondent was only able to select one option. This reduced confusion and ensured that respondents would make a choice. They were asked to rate the workplace environment - when they feel most stimulated, and the relationship between stimulation and the environment. They were also asked to assess how productive they felt on their most recent full day at work in relation to their normal performance. The aim was to elicit responses that were not the result of social-desirability bias, or over-estimation of productivity.

Two workplaces had fewer than thirty users and therefore all users were surveyed in those instances. In the other fourteen workplaces, in accordance with the Central Limit Theorem [83-84] a random sample of thirty users from each organisation was selected from staff lists, which ensured that everybody had an equal chance of being involved. The random selection yielded a total sample of 458 users from all levels of the organisations, spread geographically throughout all the workplaces. Of the users surveyed, 40% were male and 46% were female (14% did not disclose) demonstrating a fairly even split. In terms of occupation, there were larger numbers of administration and professional staff surveyed than managers and directors. This is a reflection of the larger numbers of these types of staff in the organisations. A

return rate of 85% was obtained which equates to 390 participants. With the high response rate, a low margin of error could be achieved as an adequate proportion of each population was sampled. Feedback on the questionnaire was positive. There was no indication that any aspect of the workplace environment had not been incorporated, and all respondents were able to complete the questionnaire in less than 30 minutes.

At the end of the three day data collection period in each workplace, a short de-briefing session was held with a senior member of staff, and each business was provided with a short report for its own workplace. All data were entered into Excel and SPSS for analysis.

3.3 Results and Analysis

3.3.1 Overview

In this Study, the independent variables are aspects of the environment grouped under the following headings - internal climate, interior design and workplace features (see Appendix: Satisfaction items 1-3). The dependent variable is perceived stimulation (see Appendix: Stimulation items 2.1–2.3). Extraneous variables, such as culture, are controlled by the large and diverse nature of the organisations. It is clear that research attention offered to the internal climate has created established design standards that were achieved, and generally satisfied the users. As part of interior design, spatial layouts were positively rated by the users in this study. The other aspects of interior design - colour, artwork and plants, were negatively rated. Workplace features also received a mixed response. Daylight received a positive response and view was on the borderline. However, personal control of the climate, choice, comfort and breaks were all negatively rated. The data were also analysed to determine the amount of variance in perceived productivity predicted by all the aspects of the workplace environment. The results showed a 3.7% variance in perceived productivity ($F=1.829$, $df=16,333$, $p<0.05$). Although not a large figure, it is still a significant result; demonstrating that there is a relationship between stimulation and perceived productivity. Ostroff [85] notes there may also be a correlation between stimulation and actual performance, although it was not possible to test it in this study. An analysis was therefore needed to discover which aspects are the most significant predictors of stimulation levels and thereby which could predict perceived productivity.

3.3.2 Predictors of Users' Perceived Stimulation

Each aspect was informed by a number of questions (see Appendix). A factor analysis was conducted in which the scales for each response were recoded so that the responses were all unipolar, and coefficient alphas were calculated to ensure that the groupings of items were reliable. Although the scales were labelled differently at their polar ends, they were deemed to be measuring the same factor and therefore were capable of being combined. All factors for the independent and dependent variables were initially entered into a regression analysis to determine whether, as a whole, they were able to predict perceived stimulation levels. The adjusted R square = 0.431 therefore the model was able to predict 43.1% of variance in stimulation, $F(16,333) = 17.56$, $P<0.001$. This demonstrates that the model containing all factors is a good predictor of the level of stimulation provided by a workplace environment. To determine which factors were the most significant predictors of perceived stimulation,

they were entered into a stepwise regression analysis. The adjusted R square = 0.423 and therefore the significant factors were able to predict 42.3% of the variance in stimulation levels, $F(1,343) = 5.474$, $p<0.05$. Thus all the discarded factors together were only able to predict 0.8% of the variance in stimulation. The most significant predictors of perceived stimulation levels are shown in Table 3. The higher the Beta number, the more significant the aspect is as a predictor. The *p* value is the probability of the result having occurred by chance. To ensure that chance is not an issue, the *p* figure should not be greater than 0.05.

Predictor Variable	**Beta**	***p***
spatial layout	0.252	< 0.001
temperature	0.163	< 0.001
air movement	0.158	< 0.001
comfort	0.135	< 0.01
plants	0.128	< 0.01
choice	0.123	< 0.05
artwork	0.117	< 0.01
colour	0.109	< 0.01
breaks	0.101	< 0.01

Table 3: Most Significant Predictors of Stimulation Levels and Perceived Productivity

The table demonstrates that a range of aspects in the workplace are able to predict perceived stimulation. These predictors are spatial layout which includes the respondents perceptions of the type of office they were in (ie open plan, cellular, etc) where they were sat within the workplace and the amount of privacy they had; temperature and air movement which include perceptions in the morning and afternoon and both summer and winter; sitting at work which includes comfort of the workstation and comfort after sitting for periods of time; attractiveness of the workplace generated by plants, artwork and colour; choice in spatial layout, artwork, decoration, furniture and personal control of the internal climate; and breaks which include perception of the size and decoration of the break area and the sense created by experiencing an alternative environment. Responses to the Workplace Evaluation showed when the users felt most alert at work (see Figure 1)

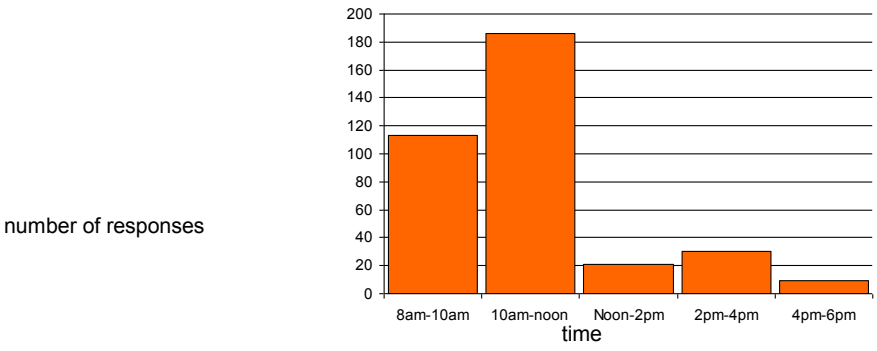

Figure 1: Time of Day when Users felt most alert

The results illustrated on this histogram correspond with previous research that found there is a sharp drop in arousal levels during and immediately after the traditional lunch break. This led to the research question for Study 2.

4.0 Study 2: Stimulation and Changes during the Day

Can changes to significant aspects of the workplace environment counteract the reduction in users' perceived stimulation from morning to afternoon?

4.1 Methodology

4.1.1 Participating Organisations

An opportunity arose when the management of two further workplaces agreed to permit a study aimed at increasing users' stimulation in the afternoons. The workplaces are a design practice with 19 employees and a financial services company with 30 employees; and are equivalent to the participating organisations from the first study (see Table 2). The procedure from Study 1 was repeated in these two workplaces, and the results evaluated to ensure consistency in every respect, with those of the original sixteen workplaces. Of the most significant predictors of stimulation from Study 1 – not all aspects could be varied during the working day, as shown in Table 4.

can be varied	**cannot be varied**
temperature	spatial Layout
air movement	comfort
artwork	choice
colour	
breaks	
plants* ⟶	plants

Table 4: Aspects that can be varied during the working day

The users were consulted about plants but they considered that varying the number between morning and afternoon would not be feasible. Nevertheless, all of the aspects should be carefully considered by architects and workplace managers at the design stage of future projects.

4.1.2 Procedure

Study 2 is a qualitative investigation aimed at exploring the issues. Each of the aspects to be varied was independently modified for a period of two weeks, within the two sample workplaces, followed by a two week period with all the changes:

- Temperature – increased by 2 deg C
- Air Movement – increased by 0.05 m/s
  (nb both are linked to the building management systems and changed up to the limit of the design range)
- Artwork – projected onto walls
- Colour – addition of red and blue lights
- Breaks – new break area in each workplace

At the end of each two week period, the users were asked to complete a qualitative evaluation, identifying any of the above aspects that had increased their perceived stimulation during the afternoons. The participants were not informed about which aspects had been modified in any of the two week periods. Feedback was also achieved from all the users in five focus groups, after the twelve weeks had elapsed, to uncover reasons behind the evaluation results.

4.2 Results and Analysis

The results from the complete twelve week experimental period of modifications showed that changes to temperature and air movement did not provide any stimulation for the users. The additional colours offered minimal stimulation. The artwork generated the greatest stimulation but the new break areas actually reduced stimulation. In the case of temperature and air movement, the focus groups revealed that the respondents in Study 1 were not actually suggesting overall changes in temperature and air movement would be stimulating. They pointed out that individuals experience temperature differently, due to metabolism, clothing, physical work, personality, preferences and a number of other factors. Thus a general temperature change through the building management system had minimal effect on stimulation. They actually meant that changes to suit the individual would be stimulating, ie personal control. This includes opening windows as a means of regulating both temperature and air movement. The artwork had a positive impact on the users. The focus groups identified that the nature scenes were particularly popular (see Figure 2), and respondents even stated that the artwork provided a talking point and encouraged greater social interaction. There were also requests for the continuation of projected artwork after the research was completed.

Figure 2: An Example of a Nature Scene projected onto a Wall

The situation with the break areas is more complex. The increased frequency of breaks to every two hours, helped with comfort, indicating that it can be varied during the working day. The new break areas are enclosed by full height partitions, separate from the main workspace and away from the visitors' waiting areas. These features should satisfy user needs for escape from work. However, users expressed dissatisfaction and negative stimulation due to the design of the break areas (see Figure 3).

Figure 3: Example of an unpopular Break Area Design

5.0 Discussion and Conclusions

The sixteen workplaces in Study 1, represent the design output of a single architectural practice, over a five year period – offering consistency of approach. The majority of users were administrators and professional staff, spending most of the working day at their workstations, operating computers. Generally, the work is repetitive, and in open plan spaces with some accommodating large numbers of people. It is important that studies should be contextualised by the workplace. Opportunity may therefore be limited by the willingness of managers to co-operate. In this instance, there was a good response to enable the researchers to seek feedback on the architects' designs. It is clear that research attention offered to the internal climate has created established design standards that can be routinely achieved. As part of interior design, spatial layouts have been the subject of a number of research projects, and were positively rated by the users in this study. The other aspects of interior design - colour, artwork and plants, were negatively rated. The users felt that they had potential but had been neglected. Workplace features also received a mixed response. Perhaps surprisingly, daylight received a positive response and view was on the borderline. However, personal control of the climate, choice, comfort and breaks were all negatively rated. The responses were grouped for analysis, and entered into a regression model to establish which are the most significant predictors of stimulation levels. Nine aspects accounted for 42.3% of the 43.1% of variance in stimulation. These aspects are spatial layout, temperature, air movement, comfort, plants, choice, artwork, colour, and breaks.

Another issue was the dramatic reduction in staff arousal levels during and immediately after the traditional lunch break, and throughout the afternoon. It was fortunate that the managers of two further workplaces which also had additional new break areas, permitted a twelve week study aimed at increasing users' stimulation in the afternoons. Study 2 was also seen as an opportunity to continue the

investigation into the aspects that had already been identified as the most significant predictors of stimulation levels in Study1. The most notable omission was the issue of plants, as users felt that varying the number of plants between morning and afternoon would not be feasible. Previous research had indicated that the number of plants in a workplace can be positively correlated with satisfaction. So, there is scope for a specific investigation into the influence of plants on stimulation in the workplace.

In Study 2, the period between breaks was reduced to two hours, in conjunction with use of the break areas; and discomfort ceased to be reported. This result suggests that the reinstatement of the mid-morning and mid-afternoon coffee and tea breaks, may have value. The introduction of the projected artwork produced the greatest effect on stimulation, with nature scenes being particularly popular. To improve interaction between workers and their environment; as well as increasing user choice – a strategy of encouraging employees to contribute their own artwork, may be worthy of consideration. The new break areas are separated from the main workspace and received a positive response in terms of escape from work. Yet, the design and décor of the break areas produced dissatisfaction and negative stimulation. There is a case that it is the role of break areas to induce relaxation and therefore generate negative stimulation, which may be worthy of further investigation but it needs to be coupled with user satisfaction. The focus groups showed that the break areas actually represent part of the dissatisfaction with choice in layout, design and décor. A methodology needs to be established for user choice to be activated during the design process. Management tend to argue for credible leadership and that every member of a large workforce cannot be taken into account. Yet, it must be possible to offer some form of choice system. For example, the architects could suggest optional layouts. Choice also needs to retain currency with turnover of the workforce. A feature of the maintenance programme should be to review the layout, design and décor of the workspace and break areas. The value of alternative provision of break areas between mornings and afternoons requires more research.

It has already been established that the additional colours had little effect on stimulation. It has also been shown that general changes to temperature and air movement did not provide any additional stimulation; and the subsequent focus groups identified that the issue was really individual control. In the assessment of internal climate, users were content with consistent humidity, illuminance and background noise. For them, the aspects that constitute environmental comfort for the individual are temperature and air movement; over which they are seeking to exercise personal preferences. An expression of this desire is the demand for openable windows. Since the latter part of the 20th Century, energy efficiency has become a priority in building design. This has led to sealed envelopes and building management systems. Workplace managers may need to consider the balance between energy efficiency, and stimulation in the workplace. Above all, and despite the difficulties in achieving agreement with managers to undertake insitu studies, continued evaluations within the workplace are essential to the guidance of appropriate design and management decisions.

These two studies have been a rare opportunity to investigate real workplaces. Where stimulation in the workplace has been investigated, the focus has tended to be on individual characteristics. These independent studies have also been mainly conducted in laboratories, which as Abdou and Lorsch [1], Kwallack and Lewis [2], and a number of others point out – loses the context and applicability of real world settings. Study 1 provides significant new information as it demonstrates the greatest predictors of stimulation from a range of aspects measured. These studies also have the added value of feeding back to both the architects and workplace

managers. Through an arrangement called the performance consultancy, the architects who designed these workplaces can incorporate the findings in their briefing dialogue for subsequent designs. This research will enable the architects to advise their clients that user choice of layout, and design and décor of workspaces and break areas, are the most significant aspects at design stage; and to neglect these matters may adversely affect the stimulation and performance of their employees. The feedback to the workplace managers is that the sharp drop in arousal levels during and immediately after the traditional lunch break, and throughout the afternoon, is still evident in their workplaces. Nevertheless, they were informed that provision of artwork, personal control of temperature and ventilation, and regular breaks are the most significant contributions to counteracting this situation and increasing the stimulation and possible productivity of their employees.

Acknowledgements

This research was partly supported through a Knowledge Transfer Partnership grant (TCS4067) funded by the British Government Technology Strategy Board. The authors also acknowledge the help and co-operation of Ryder Architecture, especially in obtaining access to the workplaces.

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